I-5 Columbia River Crossing Partnership:
Traffic and Tolling Analysis

Evaluation of Toll Facility Design Options

Working Paper 8.0

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OVERVIEW

Working Paper (WP) 8.0 addresses toll plaza design concepts for I-5 and I-205 in both Washington and Oregon. Potential toll collection facilities were evaluated for each of the four Columbia River crossing concepts that were included in the I-5 Transportation and Trade Corridor project. Designs were developed at a conceptual level in the context of design guidelines and potential impacts to existing land use.

This WP includes six sections:

1. The case for why toll plazas are needed for toll collection rather than relying on 100% electronic toll collection (ETC) is presented.

2. Design parameters and guidelines are provided to help determine footprints required for siting toll plazas for I-5 and I-205.

3. Results from a Toll Plaza Design Workshop are presented. The purpose of the workshop was to gain a better understanding of the impacts of siting toll plazas for each of the four river crossing concepts studied in the I-5 Transportation and Trade Partnership project.

4. Costs and right-of-way impacts are discussed for the potential toll plaza sites in Washington and Oregon on I-5 and I-205.

5. Other factors affecting toll plaza design are presented.

6. Recommendations and conclusions are presented.

1.0 WHY A TOLL PLAZA?

With the advent of ETC, technology will allow for high-speed collection of tolls across the existing I-5 and I-205 lanes without the need for toll plazas. However, it is not that simple. In an ideal situation, all vehicles would be fitted with transponders and have the toll charged against a pre-established account. In reality, under the best of circumstances, it is unlikely that more than 60% of the vehicles will have transponders for the Columbia River Crossings, and these rates would most likely not be achieved within the first five years of operation.

The negative on 100% ETC is there is no inexpensive system available to efficiently collect tolls from those who do not have transponders. For vehicles that are not transponder-equipped, a series of video images captures their license plate. Computers using optical character recognition software read the video image of the plate, and once the vehicle has been identified, its registration is checked through the various motor vehicle agencies to obtain a billing address. A bill is sent to the registered owner of the vehicle. The cost per transaction can range from $2.00 to $5.00. By comparison, the cost per transaction for collection in a toll plaza is in the $0.25 to $0.45 depending on whether ETC or manual. Transaction costs can be at the lower range if toll operators are allowed to store license plate information for frequent users and send monthly bills. Laws aimed at protecting private information often ban toll operators from storing license plate information, which means every transaction would need to be checked daily.

To put the problem in perspective, in the start-up years, the number of non-transponder users crossing the Columbia River is estimated at 80-90,000 vehicles per day (or 24-28 million transactions per year). As transponder use increases, the total number of vehicles would also increase based on normal growth in population, employment, and demand. After five years, the number of non-transponder equipped vehicles could still be in the 100,000 vehicles per day range (or more than 31 million transactions per year).

Another issue to consider is that although the video image is taken of a license plate, it cannot be assumed that 100% of these transactions would pay. There is little information available on what percentages of video transactions are "lost", because the information is proprietary to the operators. Combining unreadable images, unbillable transactions and uncollectable bills, an estimate of 30% to 40% loss is not an unreasonable estimate.

Privacy and policy issues also create roadblocks for 100% reliance on ETC. Many toll users do not like the thought of government or operating agencies having knowledge of their whereabouts and access to information they regard as private. National and local policies also create problems for increasing use of transponders. For example, there are no national standards for dedicated short-range communication (DSRC) protocols that could lead to universal transponders that could easily allow any vehicle access to any tolled facility in the United States. Some say the United States is at least ten years away from when all vehicles sold in the United States are manufactured with built-in transponders.

For the purposes of evaluating tolling scenarios for the I-5 Columbia River Crossing project in the Draft Environmental Impact Statement (DEIS), the worst case scenario is to assume that 100% reliance on ETC will not be practical. Therefore, collection of tolls through a combination of high-speed ETC lanes and tollbooths will most likely be required.

2.0 DESIGN PARAMETERS FOR TOLL PLAZAS

A toll plaza is defined as the area where tolls are collected and typically consists of a toll collection point, toll islands, and a protective canopy. Toll plaza design has evolved over the past 50 years to several basic configurations influenced largely by traffic demand, customer profile, type of toll system, methods of toll collection, toll rate schedule, and the physical environmental constraints of the site.

No general standards exist for the design of toll plazas. The only standards are those that have been developed by toll operators based on their experience and through applying improvements for upgrading existing facilities or building new ones. Elements of toll plaza design vary from agency to agency and state to state. To help guide the designer, the Transportation Research Board published NCHRP Synthesis 240, in 1997 (Schaufler), which provided a range of design criteria used in existing toll plazas throughout the United States. At the time of the publication, ETC was relatively new and design data was limited.

Subsequently, horizontal and vertical design guidelines for toll plazas were provided in research published in the Journal of Transportation Engineering, May/June 2001, (McDonald and Stammer). Recommendations were established for toll lane configuration, approach tapers, departure tapers, queue area length, recovery zone length, toll lane widths, lane configuration, pavement cross slopes, profile grades, and sight distance modifications. These guidelines were generated from a review of current practices from 13 toll authorities in the United States.

2.1 Toll Plaza Configuration

Toll plazas for I-5 will fall into two categories, mainline and ramp. **Figure 1** shows the basic elements of a mainline toll plaza (Journal of Transportation Engineering, McDonald Jr. and Stammer Jr., May/June 2001, page 217). These elements include the approach (transition) zone where vehicles maneuver from the mainline lanes to the tollbooth; the queue area where vehicles wait for toll collection; the toll island slab where the tollbooths are located; the recovery area where the vehicle exits the tollbooth; and, the departure (transition) zone where vehicles maneuver back into the mainline freeway. In addition, the plaza includes all signing, illumination, and facilities required for the plaza to function.

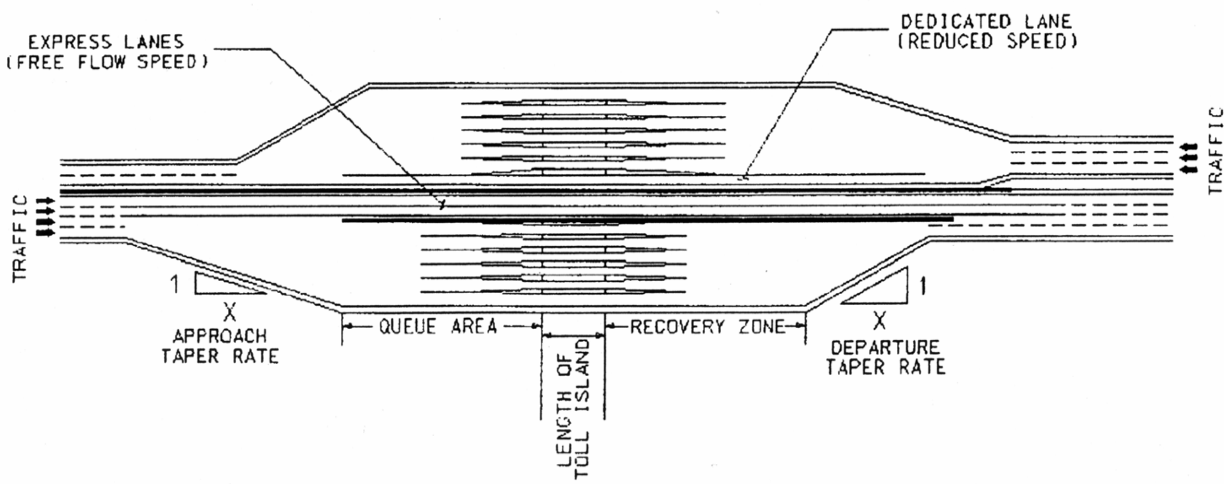

FIG. 1. Toll Plaza Elements—Plan View

The size of the plaza is based on the number of tollbooths and the total width of the toll lanes and islands. The number of tollbooths depends on the methods of toll collection, total anticipated hourly traffic, and rate of vehicle processing. For example, high-speed ETC lanes can process about 2000 vehicles per hour and toll plaza ETC lanes can process about 1,200 vehicles per hour. Tollbooth manual collection can process between 200-400 vehicles or higher per hour based on method of payment and types of vehicles. More tollbooths add to the width of the toll plaza and require longer transition tapers.

Therefore, the percentage of vehicles that can be processed through high-speed ETC lanes is an important consideration in the plaza footprint. The higher the percentage of ETC, the fewer number of tollbooths are required. For the purposes of developing conceptual designs for I-5 and I-205, an ETC share of 40% is assumed. (WP 5.3 estimates an ETC rate of 35-45% of market share three to five years after opening. The Tacoma Narrows Bridge toll facilities are designed for a 40% market share.)

Another factor impacting the size of the mainline toll plaza is its location and relationship to connecting ramps. For example, placing the plaza at close proximity to the Columbia River crossing at a location that captures most of the crossing traffic will require a larger plaza than locating the facility further away from the crossing. Plazas located further away from the Columbia River means that some traffic will enter I-5 or I-205 after the toll plaza, and their tolls will need to be collected at the ramp connections with the mainline.

For comparison purposes, the peak hour number of trips crossing the Columbia River in year 2020 is estimated at 9,800 based on data from the I-5 Transportation and Trade Partnership project. However, just north of Mill Plain on I-5 in Vancouver, the mainline volume is estimated at 5,400 vehicles per peak hour. The remaining vehicles are entering between Mill Plain and the River.

Mainline Plaza Lane Requirements

Following are assumptions used in estimating the size of toll plazas needed for the I-5 mainline crossings. It is important to note that processing rates used in this analysis are based on averages. Actual processing rates will depend on the methods of collection, the amount of the toll, and types of vehicles being processed. For example, passenger vehicles can move through a tollbooth more quickly than large trucks. More detailed analysis will be required to accurately estimate the number of toll lanes required for each individual site.

- At 5,400 vehicles per peak hour and an ETC rate of 40%, the ETC processing demand is 2,160 vehicles per hour. One high-speed ETC lane can handle 2,000 and one tollbooth ETC lane can handle 1,200 vehicles per hour on average. Therefore two ETC lanes would be required. This leaves 3,240 vehicles (5,400 – 2,160) that would need tolls collected through tollbooths. At an average processing rate of 350 vehicles per hour, ten tollbooth lanes would be required.

- At 9,800 vehicles per peak hour and an ETC rate of 40%, the ETC processing demand is 3,920 vehicles per hour. Depending on the mix of high speed and tollbooth ETC, three ETC lanes would be required. The remaining 5,880 vph would require approximately 17 tollbooths, using an average processing rate of 350 vph.

- A similar process can be used to estimate the needs for plazas located at ramp connections to the interstate. However, high-speed ETC lanes will not be used at the ramp connections because lower speeds are acceptable. Therefore all vehicles entering from ramps will be treated on a case-by-case method.

Toll Rates, ETC Penetration Rates, and Processing Rates

Initially toll rates should be kept easy (fast) to collect in non ETC lanes. Processing rates vary significantly for differing toll amounts. For example, $1.00 is a lot easier and faster to collect than $.80. Therefore the processing rate for $.80 will be significantly lower and need more toll lanes than the higher rate. This is true in both attended and automatic toll lanes (although it is unlikely that automatic lanes will be implemented in this project). And, it is unlikely that 40% of toll transactions will be ETC on opening day. A marketing strategy needs to be developed early on and an anticipated ETC penetration rate developed so that toll plaza design and planning can be done in conjunction with the development of the Interstate alignment concepts. Toll lane gates reduce lane processing rates by 2 to 4 vehicles per minute. At larger plazas this can reduce plaza throughput enough to require additional toll lanes to process traffic. Gates would be used in ETC lanes and Automatic lanes in the plaza if the toll agency were not willing to experience any losses in toll revenue.

Plaza Dimensions

NCHRP Synthesis 240 (1997), Toll Plaza Design, established basic design considerations for toll plazas. Horizontal and vertical design guidelines for toll plazas were provided in research published in the Journal of Transportation Engineering, May/June 2001 (McDonald and Stammer). The latter document recommended guidelines for approach taper rates, departure taper rates, queue area length, recovery zone length, toll lane widths, lane configurations, pavement cross slope, profile grades, and sight distance.

ODOT, WSDOT and FHWA will most likely use these guidelines to review possible plaza layouts for conformity to acceptable standards. However, all three agencies have processes for approving design exceptions. Ultimately, the final plaza configurations will most likely need to either meet the guidelines, or include design features that allow for exceptions.

Following are discussions of the key design considerations. Please refer to Figure 1 for a description of the basic elements.

High-Speed ETC Lanes

High-speed ETC lanes are separated from traditional traffic by barrier walls to allow for free-flow freeway speeds. Dedicated ETC lanes use the barrier to protect the high-speed traffic from other traffic entering the tollbooths, preventing last second weaves/maneuvers for the vehicle operators who are faced with indecision as to where they need to be. Signing for the express ETC lanes is done far in advance of the toll plaza. ETC lanes will be on the left inside lanes of I-5 and the use of barriers requires standard shoulders on either side of the through lanes. The cross section from the median barrier for two ETC high-speed lanes would be a four foot shoulder on the left, two 12-foot lanes, and a ten-foot shoulder on the right for a total pavement width of 38 feet.

Approach Transition

Toll plazas involve the addition of lanes where high-speed interstate traffic will transition from the mainline to a barrier of tollbooths. Traffic must slow within the unstriped approach transition and maneuver into the designated striped queue area for entry into the tollbooths. In general, taper rates vary by approach speed. Longer transitions are required for higher-entry speeds, and conversely shorter transitions are used for lower-entry speeds. In Oregon, I-5 is posted at 55 miles per hour (mph). At that entry speed, guidelines would recommend a taper rate of 21 feet in length for every one foot of width. For an entry speed of 30 mph, the taper can be a ratio of 9 to 1. However, on the interstate, state and federal guidelines often require that a design speed be used that is 10 mph higher than posted.

Approach speeds can be reduced on the interstate by extensive advanced signing alerting drivers to the approaching toll barrier. Also a barrier toll plaza by definition requires traffic to "stop" and pay a toll. Highway design parameters within the plaza area should be able to be adjusted to accommodate traffic operational and safety needs, as well as, provide for toll collector safety.

The following assumptions were made for determining approach taper lengths.

Table 1. Approach Taper Length Assumptions

Mainline Volume	Approach Speed	Taper Rate	Number of Booths	Plaza Width	Distance
9,800 vph	55 mph	21:1	16-18	325-360 feet	6,825-7,560 feet
9,800 vph	30 mph	9:1	16-18	325-360 feet	2,925-3,240 feet
5,400 vph	55 mph	21:1	10-12	220-255 feet	4,620-5,355 feet
5,400 vph	30 mph	9:1	10-12	220-255 feet	1,980-2,295 feet

Therefore, the impacts of approach speed are dramatic based on the design approach speed used and where the plaza is located. A plaza located close to the bridge crossing that requires collection for all vehicles will need a wider toll barrier than one located further away from the bridge where tolls will be collected from entering ramp traffic separately.

Queue Area

The queue area is used to safely store vehicles waiting to enter the tollbooth. Two methods are used to design the queue length. One is to allow some of the vehicles to stack up in the approach taper and the other is to design the queue length to handle all overflow vehicles when the design traffic volumes are exceeded. Queue area requirements can also be modeled using VISSIM or other simulation packages. Queue lengths were not modeled for this tolling analysis. Synthesis of current practices suggests that an adequate queue length ranges between 200 to 250 feet. For the purposes of this study, a length of 250 feet was used.

Toll Islands

Toll islands are raised platforms, usually made of concrete that include crash protection devices on the approach and a toll collection booth. The NCHRP 240 Synthesis reviewed 36 configurations of toll islands used by the 46 facilities that responded. In other words, there is latitude on how the toll islands are configured. Toll booths are typically about 3.5 feet wide, and the toll islands are about 6.5 feet wide and about 100 feet in length.

For large plazas, access to the toll booths can be through a tunnels or an overhead walkway. Access only needs to be provided often enough to reduce the number of toll lanes an attendant would need to cross to reach their assigned tollbooth. Often, one or more of the tollbooths are set up to handle wheelchairs for attendants with disabilities. Large sums of cash will be collected at the toll plaza, and security is another issue for accessing tollbooths.

Toll lane widths through the islands impact the total barrier width. The lanes need to be narrow enough to assure the vehicle operator stops close to the attendant or pay machine, and yet wide enough to safely handle both passenger cars and trucks. Lanes with substantial truck traffic should be 11 feet wide, with high truck traffic, 12 feet wide, and for wide load lanes, 14-18 feet wide. In the I-5 study, a toll lane width of 11 feet is recommended and a wide load width of 14 feet.

Lane configuration relates to the operating agency's policy on arranging toll lanes at the plaza. Several different types of payment methods will most likely be in place ranging from ETC to manual collection by an attendant. Most systems use electronic payment or higher processing type payment systems on the left with full service systems on the right. This pattern follows the convention on the roadway that faster traffic uses the left lanes and slower traffic keeps right. Within the Bridge Influence Area (BIA) on I-5, the number of access points and high number of vehicles entering and leaving the freeway, will need to consider what works best. For some ramp connections, tolls can be collected on the ramp. For other areas, ramps may connect within the approach transition area and may require a different setup. For this analysis, how the lanes are configured should not have a bearing for evaluating the impact of the plaza footprint.

Tandem/branch toll lanes can be used to add toll collection capacity where right-of-way restricts the footprint of a wider facility. This strategy is recommended for I-5 and I-205 where there will be lower use of the ETC lanes during the start-up period. The concept of tandem tollbooths is use two manual booths placed in the same toll lane, permitting simultaneous processing of two vehicles. Branch toll lanes occur when one host lane branches into two separate toll lanes downstream of the barrier. In one case, a single host lane was able to accommodate up to 1,100 vehicles per hour.

In this tolling analysis, a toll island width of 6.5 feet and island length of 100 feet was used. Toll lane widths were assumed at 11 feet with at least one lane designated for over wide vehicles at 14 feet.

Recovery Zone

The recovery zone is the space immediately beyond the collection barrier needed for vehicle operators to view their position in relationship to others in near proximity. It provides a safe haven prior to maneuvering in the departure transition to the mainline lanes. A recovery zone length equal to the queue length or between 75-150 feet is recommended especially when longer trucks are present. For the purpose of this study, a recovery zone length of 150 feet is recommended.

Departure Transition

The departure transition is used to allow vehicles a safe distance to merge with other vehicles leaving the toll barrier. Taper rates, based on the guidelines, range from a low of 5:1 (five feet in length for every foot in width) to as high as 22:1. For illustrative purposes, a recovery zone length of 150 feet and a taper rate of 9:1 would allow an entering vehicle to reach an approximate speed of 30 mph at the end of the taper. Since all vehicles going through the toll booth face similar conditions and are entering 3 dedicated lanes at the river crossing, it isn't necessary to be at freeway speeds once entering the mainline lanes. For high-speed through traffic, the barrier on the express lanes can be extended until vehicles entering from the tollbooths can reach merging freeway speeds.

For the purpose of this study, a departure taper rate of 9:1 or less is considered acceptable.

2.2 Summary of Toll Plaza Dimensions

Figure 2 & 3 at the end of this working paper shows the typical mainline toll plaza layouts for a plaza located close to the Columbia River that needs to accommodate nearly 10,000 peak hour trips, and one located further away from the river designed for under 6,000 peak hour trips. The latter would need additional toll collection points on the connecting ramps.

A toll plaza on I-5 or I-205 that meets guidelines could be more than a mile long from beginning of the approach taper to end of the departure taper if reduced entry speeds are allowed. The width from median to outer edge of the toll plaza could be approximately 220-360 feet. This depends on whether the plaza is located close to the bridge for tolling all mainline traffic crossing the river, or located further away where some of the tolling will be collected on the ramps. For comparison purposes, this equates to between eight and 23 acres of additional pavement required for the two mainline toll plaza scenarios. The smaller footprint for the mainline plaza would require additional areas for the ramp plazas. Since the toll collection facilities on the ramps would serve lower speeds, a smaller overall footprint could be used when tolls are collected on both the mainline and connecting ramps.

3.0 TOLL PLAZA DESIGN WORKSHOP

Finding a suitable site for a major toll of this size and configuration in either Vancouver or Portland will be challenging. In fact, many toll plazas in use throughout the United States have a much smaller footprint than proposed in the guidelines.

A toll plaza design workshop was held on August 25, 2004 for the purpose of gaining a better understanding of the impacts of siting toll plazas for each of the four river crossing concepts studied in the I-5 Transportation and Trade Partnership project. Experts on interstate freeway design from ODOT, WSDOT and Consultants, and toll plaza design experts from Vollmer and WSDOT participated in the workshop to help identify design parameters and introduce opportunities for "right-sizing" the plaza design to fit within the constraints of the adjacent land use.

Charles McManus from Vollmer Associates made a presentation to the workshop participants outlining innovative options to safely place toll plazas in urban communities with very limited space. He discussed methods for connecting ramps to toll collection facilities, how to get more vehicles through a plaza, and generally described what works and what doesn't work. Mr. McManus, while previously with the New Jersey Highway Authority, was on the topic panel for oversight of the NCHRP Synthesis 240, on Toll Plaza Design (1997), and is considered an expert in developing toll plazas in the Northeastern United States.

3.1 Workshop Assumptions for Siting Toll Plazas

The following assumptions were made in reviewing potential sites for placing toll plazas on I-5 and I-205.

- Tolling options should have the potential to provide sufficient revenue to recover capital, maintenance, and operational costs of the new facilities—within the framework of potential state and regional policies.

- There are no national standards for design of toll plazas. However, guidelines have been developed that are a synthesis of design practices used for existing facilities located throughout the United States. For the purpose of finding acceptable sites for toll plazas, it is assumed that deviations from the guidelines will be acceptable if approved by the state DOT with jurisdiction and FHWA, depending on whether located in Oregon or Washington.

- Scenarios should include options that allow for the existing bridges on I-5 and the existing bridge on I-205 to be tolled, as well as tolling new capacity across the river.

- Toll plazas can be located either in Washington or Oregon. Tolls can be collected one direction or two directions. If one direction, they can toll either southbound (SB) or northbound (NB).

- If tolls are to be collected in both directions, toll facilities should ideally be sited in close proximity to reduce operational costs.

- Efforts should be made to avoid historic places, mitigation areas, and to minimize the impact on other sensitive areas such as neighborhoods, wetlands, and parks.

- All standard options for collecting tolls should be considered, such as ETC, manual, automatic coin machines, tokens, use of toll gates, bar code readers, credit card, and tickets.

- Because of policy issues such as concerns for privacy and the practical limitations of technology, it is premature to assume that 100% electronic toll collection will be practicable in the immediate future. For design purposes, an assumption of 40% ETC is satisfactory for testing toll plaza configurations.

- Toll lane capacities, the number of vehicles per hour per lane that can be handled, should follow averages as outlined in NCHRP Synthesis 240.

- Innovative methods to minimize toll plaza footprints should be considered.

3.2 Preliminary Analysis of Potential Toll Plaza Sites in Washington and Oregon

It is important to note that members or representatives from the Regional Coordinating Committee did not participate in the design workshop. Future participation and input from the members of the RCC will be crucial in the development of possible toll plaza locations. Therefore, the conclusions from the initial analysis are intended to be only a starting point in understanding potential problems in siting toll plazas on either I-5 or I-205 in either Washington or Oregon.

Following are initial evaluations, based on the assumptions described above, relating to the placement of toll plazas for the four concepts developed within the BIA for the I-5 Transportation and Trade Partnership project. They are evaluated in the order reviewed in the workshop.

Concept 4 – New double deck 5- lanes in each direction, LRT on separate structure

Washington

The workshop team began on the I-5 Washington side in Vancouver by identifying adjacent land uses that were considered high risk for taking right-of-way. Historic properties located in close proximity to the right-of-way along the eastside of I-5 between SR 14 and Mill Plain Boulevard made it unlikely that a NB toll plaza could be located in Washington.

Given that some minor encroachment would be more acceptable on the west side, two potential SB plaza sites were possible. One would be in the area of the Mill Plain interchange, and the other within the SR 14 Interchange.

The SB plaza at Mill Plain would be designed to handle about 5,400 mainline vehicles per hour. **Figure 4**. This requires two ETC lanes and approximately ten tollbooths. Transitions to the toll barrier would begin about 2,000 feet north, and end about 2,000 feet to the south. Ramps would require their own collection facilities. About 1,800 vehicles enter I-5 from Vancouver, and an additional 1,800 from the combined ramps at SR 14 interchange. These facilities will require one ETC lane and up to three tollbooths at each ramp location.

A SB plaza could also be located within the SR 14 interchange just north of the SR 14 overcrossing. **Figure 5**. This location allows for all tolls from both the mainline and connecting ramps to be collected within the plaza to accommodate about 9,800 peak hour vehicles. This could require up to three mainline high-speed ETC lanes and 15 tollbooths. Initially two mainline ETC lanes would be sufficient based on lower start-up ETC use, but would require more tollbooths, so the footprint would be about the same. Some of the tollbooths could be tandem or branched, or tolls could be collected on the SR 14 approach ramps to reduce the plaza size. Major redesign of the SR 14 interchange would be required to accommodate the plaza. Current concepts for the freeway to freeway connections between I-5 and SR 14 have support piers for the overcrossing structures located within the approach to the toll barrier, which could not be allowed. Therefore, the freeway ramp connections from I-5 to SR 14 would need to go under the toll plaza, and the plaza would all be on structure. Transitions will require additional right-of-way and will likely impact the BNSF RR overcrossing structure.

Oregon

On the Oregon side, toll plaza sites were examined between the Marine Drive Interchange and the Columbia River, including on Hayden Island. South of Marine drive, Delta Park is adjacent to I-5 along the east side, and on the west side, wetland mitigation areas are proposed. The workshop team recommended that the best location for a SB plaza in Oregon would be along the west side of I-5 on Hayden Island. **Figure 6**. The west side of I-5 appeared to be more favorable than the eastside on Hayden Island because the northbound lanes in this area were elevated and connecting grades were much more difficult.

Transitions for a SB toll facility on Hayden Island would need to extend over water on both sides to accommodate the approach and departure transitions. The SB off ramp to Hayden Island would need to be tolled separately. Toll facilities would need to accommodate about 8,100 SB mainline vehicles and 900 SB vehicles exiting to Hayden Island. The mainline toll facility would require two to three ETC lanes and 14 tollbooths. For the SB off ramp, one ETC lane and two tollbooths would be required. Much of the area between I-5 and the parallel arterial to the west would be required for the toll plaza.

If recommendations for tolling is for both directions on I-5, then more design work will be needed to test the feasibility of placing both northbound and SB toll plazas opposite each other. The most likely site for a combined plaza appears to be on Hayden Island, which would have significantly higher costs and require major re-design of Concept 4 in this area.

Recommendations, Concept 4

Based on the initial evaluation, there were three potential sites for a toll plaza that would serve SB traffic. Two sites were in Washington and one in Oregon on Hayden Island. The team was unable to recommend any good sites in either state for northbound traffic. All of the sites would require redesign of Concept 4 to verify their feasibility. And, all of the sites will require innovative approaches to allow for smaller footprints than recommended by guidelines. Further analysis will be required to accommodate toll collections facilities for both directions if only I-5 is tolled.

Concept 7 – Three SB lanes on existing west bridge, HOV only, SB and NB on existing east bridge, 3 NB lanes on new bridge east of existing bridges, and 2 arterial lanes and LRT on new bridge west of existing bridges

Washington

Solutions in Washington could be very similar to solutions for Concept 4. A barrier plaza could be designed for SB toll collection at either a location near Mill Plain, or within the SR 14 Interchange for SB traffic. See **Figures 7 and 8**. One difference in Concept 7 is the arterial roadway that crosses the Columbia River on the LRT structure west of the existing bridges. For either plaza design, the arterial river crossing would need a separate toll plaza. The tight radius and vertical alignment from WB SR 14 to SB I-5 may require the toll plaza for the ramp be moved back to SR 14 at the east end of the interchange, which could be problematic or a fatal flaw if it impacts Ft. Vancouver.

Oregon

Locating a toll plaza for SB traffic on Hayden Island is doable but more problematic because of the LRT alignment that parallels the west side of I-5, and because the center HOV facility is divided and will require a separate toll collection facility. **Figure 9**. The LRT alignment shown in Concept 7 could potentially be changed to avoid the toll plaza (this needs to be verified). The options for siting a plaza in Oregon would probably be more costly under Concept 7 than in Concept 4. However, the overall project costs would govern whether a more expensive toll collection facility in Oregon is a better idea. Making the center HOV roadway an ETC only lane will solve the problem of a separate toll plaza for the center roadway.

Recommendations, Concept 7

Options for siting toll collection facilities under Concept 7 creates more problems than for Option 4. This concept uses the existing bridges with lift spans. Initial evaluation appears that it will be more cost effective to site the plaza in Washington, rather in Oregon, to serve SB traffic. Another problem with siting the toll plaza in Oregon on Hayden Island is the impact of lift operations and resulting queuing. After the lift spans closes, a slug of traffic will be released and overcrowd the downstream plaza. Vehicles waiting for the lift span to close will need to wait again to get through the toll plaza. There were no good options for siting a NB plaza under Concept 7. Again, all of the sites will require smaller footprints than recommended by guidelines in order to minimize impacts to adjacent land uses.

Concept 1 – 5-lane SB on new double-deck bridge, LRT on lower deck west of existing bridges, and 5 NB lanes on existing bridges

Washington

Placement of the new I-5 bridge to the west of the existing bridges for SB traffic creates alignment issues that make siting a toll plaza within the SR 14 Interchange a fatal flaw. The approach alignment, on a curve, is less than desirable for providing a safe approach to the tollbooths. And, the plaza footprint would result in an unacceptable ramp alignment for the WB SR 14 to SB I-5 movement. It is still a viable option to site the SB toll plaza within the East Mill Plain Interchange. **Figure 10 and 11**. Therefore, there is only one option, the East Mill Plain site, that will work in Washington. As with the other concepts, siting a NB toll plaza in Washington is not recommended.

Oregon

For Concept 1, consideration could be given to placing a toll plaza on the eastside of Hayden Island. The westside, unlike the other concepts, would not work for Concept 1 because the new elevated bridge is located on the westside of I-5 and connections would be impractical. Right of way and land use impacts might be greater on the eastside than the westside. Major redesign of the Concept 1 alignments on Hayden Island will be required to accommodate a toll plaza.

Recommendations, Concept 1

Placement of the new bridge to the west of the existing bridges complicates siting of a toll plaza under this option. Based on initial evaluation, it appears that the best location for a toll plaza for Concept 1 is at the SB East Mill Plain Interchange. The SB on ramp from SR 14 would require toll collection on SR 14 because the tight overcrossing radius to I-5 will not work. Ramps from Vancouver to I-5 south of the East Mill Plain toll plaza will need to be tolled separately.

Concept 6 – 4-lane supplemental collector-distributor bridge w/LRT, plus 6 lane freeway

Concept 6 provides for a new four-lane bridge with LRT located west of the existing I-5 bridges. The existing bridges will continue to carry three lanes of interstate traffic in each direction. The workshop team did not see any feasible solutions for siting a toll plaza for this option because of the design conflicts generated by the split traffic and assumption that all Columbia River Crossing traffic should be tolled.

Recommendations, Concept 6

Lack of opportunity to site a toll plaza suggests that Concept 6 be dropped from consideration if toll collection is part proposed in the DEIS.

I-205 Toll Collection Facilities

Washington

I-205 connector ramps for the interchanges north of the SR 14 overcrossing are scheduled for major reconstruction. Planned collector-distributor ramps north of SR 14 will utilize all available right of way and impact siting of plaza facilities. Further north, there are opportunities in the median to site either a NB or SB mainline plaza. However, moving the collection point this far north creates other problems with picking up tolls for vehicles crossing the river while providing by-pass options for those who are not. Potentially, there is an acceptable toll plaza site for SB traffic near the SR 14 overcrossing. **Figure 12**. Placing a plaza at this location will require reconstruction of the SR 14 interchange ramps. There were no viable options for placing a toll plaza for NB vehicles in the SR 14 interchange area.

Oregon

The team did not have the time to investigate the feasibility of siting a toll plaza, either NB or SB, on Government Island. One advantage of placing a toll plaza on Government Island is the ability to collect 100% of the tolls on one facility because there are no ramps in close proximity that would require separate toll collection. The next feasible site in Oregon would be within the Airport Way Interchange for SB. **Figure 13**. Major redesign of the ramps will be required to accommodate the plaza. There were no good options for siting a NB plaza between Sandy Boulevard and the River due to constrained right-of-way on the eastside of I-205.

Recommendations for I-205

The best location for a toll plaza appears to be SB within the SR 14 Interchange. Options should be investigated for siting a plaza on Government Island. Siting of a toll plaza on I-205 will require major interchange reconstruction to realign ramps at the SR 14 Interchange location.

3.3 Workshop Conclusions for Siting Toll Plazas

- Toll collection facilities were not considered when designing the build concepts for the I-5 Transportation and Trade Partnership project. Providing toll facilities will require modifications to the existing concepts.
- Future participation and input from the Regional Coordinating Committee representatives will be crucial in the development of possible toll plaza locations.
- In the initial workshop evaluation, no easily identifiable sites were found that would allow for efficient collection of two-way tolls. This was under the assumption that toll plazas should be located in close proximity for both NB and SB traffic to allow for a single administration

building and common facilities. If two-way tolls are to be collected under a scenario where only I-5 is tolled, additional design work will be required for optimal siting of two-way toll plazas.

- There were no practical northbound toll plaza sites in Washington because the footprint would encroach on the historic properties located between SR 14 and East Mill Plain. Northbound plaza sites in Oregon appear to have greater property impacts than SB sites.

- Based upon initial analysis of the physical options, it looks like it will be easier to design and locate toll facilities in the SB direction for both I-5 and I-205 in either Washington or Oregon.

- Concept 4, which provided for five new lanes in each direction on a double deck high span bridge, appeared to provide the most flexibility to site toll plazas. Options that used the existing bridges and options that included arterials were more difficult to design for toll collection due to split alignments.

- All of the toll plaza sites will require further design analyses to confirm their footprint and how they can be integrated into each of the design options.

- All of the toll plaza concepts will require innovative siting techniques that rely on approach and departure taper rates that can be designed to meet acceptable interstate standards and can be approved by the state with jurisdiction and FHWA.

- Placement of ETC lanes that allow for high speed toll collection in the center lanes will create weave conflicts for vehicles wanting to enter or leave the interstate system in close proximity of the toll plaza. This is due to having eight interchanges within four miles within the Bridge Influence Area. Additional traffic analysis will be required to analyze travel demand and assess the impacts of varying toll plaza sites and layouts.

4.0 COSTS AND RIGHT-OF-WAY IMPACTS

Cost estimates were developed for five very conceptual toll plaza layouts located in Washington and Oregon on I-5 and I-205. All costs are for the toll plaza only. Major roadway revisions, unless unique to the toll plaza design, are considered to be included in the mainline reconstruction costs. No attempt was made to evaluate the environmental impacts for each plaza site.

The designs were based on Option 4, which provided for five new lanes in each direction on a new high level bridge across the Columbia River. Concepts were developed from estimated horizontal and vertical clearances. In some cases designs intentionally recognized that deviations from standards or guidelines will be required. Following are descriptions of the five sites.

4.1 Southbound I-5 near Mill Plain in Vancouver

A SB plaza near Mill Plain would provide for mainline tolling on I-5 to accommodate about 5,400 mainline vehicles per hour. The total added width at the toll barrier would require an additional 168 feet of pavement and stretch about 4,000 ft. along I-5 from beginning of the approach zone to end of the departure zone. (Assuming approach and departure speeds at 30 mph.) The toll plaza footprint is estimated to add about 11 acres in new pavement area. Approximately 6.5 acres of additional right of way would be needed on the west side of I-5. Right of way costs were estimated to be relatively high because of the impacts to commercial properties located south of Mill Plain Blvd.

Connecting ramps between the toll barrier and the Columbia River would need to be tolled separately. These facilities could be located within existing right-of-way. Designs were not developed for the ramp toll collection facilities.

The estimated cost of a toll collection facility at this location is between $120-165 million

4.2 Southbound I-5 at SR 14 in Vancouver

A toll barrier located near the SR 14 crossing would require additional mainline tollbooths, but some of the tollbooths could be located on SR 14 where the ramp connects with I-5 to reduce the mainline plaza footprint. The approach zone and departure zones could be "squeezed" to reduce right-of-way impacts in the commercial area south of Mill Plain, and to avoid carrying the departure zone onto the new Columbia River Bridge. This may be acceptable because the departure lanes from the toll plaza would feed into dedicated lanes on the Columbia River crossing. The concepts that are proposed for this plaza design would require approval for design deviations from WSDOT and FHWA. The toll plaza footprint would cover about 10 acres of new pavement area and need about 6 acres of additional right-of-way. Nearly the entire toll plaza would be located on structure.

The estimated cost of a toll collection facility at this location is between $135-175 million.

4.3 Southbound I-5 on Hayden Island

Hayden Island is approximately a half-mile from north shore to south shore. Along with the toll plaza, I-5 on-off connections are needed for access to Hayden Island. In addition, this concept provides for a light rail stop on the island. A toll plaza footprint at this site needs to be "squeezed" to fit with the site constraints and also will need approval for design deviations. The toll plaza would be on structure and extend over the water on both sides of Hayden Island. Approximately 10 acres of added pavement would be needed along with 11 acres of right-of-way.

This is the most expensive site for a toll plaza on I-5 because of the tight site constraints combined with the need to provide access for vehicles and light rail. The estimated cost of a toll collection facility at this location is between $200-250 million.

4.4 Southbound on I-205 at SR 14 in Vancouver

A concept was developed for siting a SB toll plaza at the SR 14 overcrossing. Northbound and southbound connections to I-205 would need to be reconstructed. Everything south of SR 14 would be on structure as the existing bridge across the Columbia River touches down at the north side of the SR 14 overcrossing. Since no other reconstruction work is proposed for I-205 in the area of the toll plaza, the costs for the plaza includes necessary ramp modifications. Again, a modified design would be needed to best fit within the site constraints. The toll plaza footprint would cover approximately 12 acres of new pavement area and require about 3 acres of new right-of-way.

The estimated cost of a toll collection facility at this location is between $110-130 million.

4.5 Southbound on I-205 at Airport Way in Portland

The toll plaza site would need to be "squeezed" between the Columbia River on the north and the light rail connection to the south. New ramp connections to the Portland International Airport would be required, as well as southbound I-205 connections to Airport Way. The southbound I-205 connection to the airport will require tolls to be collected on the off-ramp because the mainline toll barrier will be located further to the south on I-205. The toll plaza footprint would cover approximately 13 acres of new pavement and require about 4 acres of new right-of-way.

The estimated cost of a toll collection facility at this location is between $125-150 million.

4.6 Summary of Toll Plaza Costs and Right-of-Way Needs

Following is **Table 2** that summarizes the costs described for the five toll plaza scenarios developed for this project. It is important to stress that these costs are very conceptual for comparison purposes only. Most of the design concepts are tailored to fit within the constraints of each plaza site and there is no guarantee that design deviations would be accepted.

Table 2. Summary of Costs for Toll Plaza Scenarios

Location	Estimated Plaza Footprint	Estimated ROW	Estimated Capital Cost
SB I-5 at Mill Plain	11 acres	6-7 acres	$120-165 million
SB I-5 at SR 14	10 acres	6 acres	$135-175 million
SB I-5 at Hayden Island	10 acres	11 acres	$200-250 million
SR I-205 at SR 14	12 acres	3 acres	$110-130 million
SR I-205 at Airport Way	13 acres	4 acres	$125-150 million

5.0 OTHER FACTORS THAT AFFECT TOLL PLAZA DESIGN

Design of toll facilities is a function of traffic demand, customers, types of toll systems, methods of toll collection, toll rate schedules, and plaza location. Working papers for the I-5 Columbia River Crossing Traffic and Tolling Analysis have addressed these issues. Factors related to the operation and maintenance of the plaza can also impact its design, particularly in the spatial needs for support facilities.

Planning for toll collection facilities typically requires preparation of an Operation and Maintenance (O&M) design report. The staffing needs, policies, operating procedures, systems, and toll collection methods are defined to aid the designers in developing facilities that meet the needs of the operator. The report is useful for everything from determining the size of the administration support building to determining how many parking spaces will be required for the staff and how they will get to the tollbooths. Following are some of the key factors that impact development of toll plazas.

5.1 Administration Building

I-5 and I-205 are located on high volume urban highways, with directional volumes projected to reach 90,000 vehicles per day at each facility. Whether both I-5 and I-205 are tolled in one direction, or if I-5 is tolled in both directions, more than 30 tollbooths may be needed and required to be staffed 24 hours a day, 7 days a week. Cash receipts for each plaza will exceed several hundred thousand dollars a day. Design of the administration building needs to include room for administration, finance, maintenance, and security functions as well as accommodations for staff such as break rooms and restrooms. Areas also need to be provided for the handling of toll revenues such as a collectors count room, banking room/vault, and loading docks. For facilities of the size envisioned for I-5 and I-205, forklifts are often needed to load armored vehicles for transfer of revenues.

The administration building needs to be located as close to the tollbooths as possible to provide easy access, safety and security. Usually this distance is within 100 feet of the toll barrier. Parking and street access needs to be provided for staff, but public access to the administration building is usually prohibited because of security issues and safety. The building also should be designed and landscaped to fit within the surrounding environment.

Accessibility is also a consideration. The building must meet local building codes that meet ADA requirements. In addition, there may be a requirement to provide employment for the physically challenged as toll collectors, requiring safe access from the administration building to designated tollbooths.

If tolls are collected in one direction for both I-5 and I-205, separate administration buildings will most likely be required at each site. If I-5 is tolled in each direction, one administration building can handle both direction tolling if plazas are located opposite each other.

5.2 Toll Lane and Booth Access

Safe access to the tollbooths is an important design consideration for the toll collection employees. The proposed plaza designs may require as many as 16-18 tollbooths in the barrier. And, revenues need to be safely transported from the booths to the administration building counting room. Large facilities like those proposed for I-5 and I-205 will need to have access either from a tunnel or overhead walkway, with stairway access to the tollbooths. Some tollbooths may need to be equipped for the physically challenged which will require an elevator for access. Tollbooths can be designed for entry that doesn't require the operator to step out into a lane.

5.3 Environmental Issues

Air quality, noise, surface water runoff, and lighting spillover will need special consideration, in addition to the other environmental impacts normally encountered on a major interstate construction project. All of the plaza sites evaluated in this report are located in fully developed urban areas.

Air Quality

Decelerating, queuing, idling, and accelerating vehicles that are entering and leaving the toll barrier will result in a concentration of emissions in the toll plaza. Modeling of emissions will be required to assure compliance with Clean Air Act Amendments. Higher use of ETC has been found to help lower carbon monoxide (CO) concentrations.

Exposure of the toll collectors to CO emissions also is a consideration in the design of the collection facilities. Positive ventilation systems can be used to draw air into the tollbooth from outside sources and create sufficient outward pressure to block incoming contaminated air. Emissions can also be vented up and away from idling vehicles stopped for toll collection.

Noise

Noise from high traffic volumes, decelerating trucks, vehicle speed, tire composition, pavement surface type, topography, and wind direction will have an effect on decibel levels within a toll plaza. Some of the sites evaluated for the I-5 and I-205 toll plazas are located in proximity to neighborhoods which are much more sensitive to noise pollution. Higher use of ETC will help reduce noise to levels that more closely mirror freeway traffic. Mitigation can include installation of noise walls and berms, as well as soundproofing of receptors through insulation or screening.

Water Quality

Plaza footprints will add between 7 and 11 acres of impervious surface. Vehicles slowing, idling, and accelerating from the toll barrier will concentrate oil, dirt, sand, and deicing materials, adding contaminants to the runoff. In addition, vehicle exhaust needs to be washed from tollbooth exteriors and canopies, adding to the pollution stream. Modern methods for treating surface water runoff should help mitigate the added contaminant loading within the plaza.

Lighting

All of the toll plaza sites investigated in this report require reduced entry speeds to lessen the impacts of the total footprint. I-5 is currently posted at 60 mph in Vancouver and 55 mph in Portland. Entry speeds of 30 mph can reduce the space needed for the approach taper to the toll lanes by half. Therefore, it will be an important design consideration to make the toll plaza as visible as possible to assure vehicles slow far in advance and enter the toll lanes at a safe speed. This can be done through high visibility overhead advanced signing combined with high light levels at night aimed at increasing driver safety and awareness. In the approach and departure zones, high light levels provide increased visibility for vehicles maneuvering in and out of the toll lanes. Both Vancouver and Portland have requirements that prohibit spillover light into adjacent properties. Proper shielding and aiming of light should help reduce the impact on adjacent properties.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The purpose of this working paper is to identify toll facility design and configuration options that would be applicable to the bridge/freeway alternatives that will be carried forward in the DEIS. Following is a summary of the key conclusions and recommendations:

- Toll collection facilities were not considered when designing the four concepts evaluated within the BIA for the I-5 Transportation and Trade Partnership project. Providing for toll collection facilities will require modifications to the existing concepts to accommodate toll plazas.

- For the purposes of evaluating tolling scenarios for the I-5 Columbia River Crossing project in the DEIS, the worse case scenario is to assume that 100% reliance on electronic toll collection will not be practicable. Therefore, collection of tolls through a combination of high-speed ETC lanes and tollbooths will most likely be required.

- Although no national standards for toll plaza design are in existence, guidelines have been developed that were used to estimate the size of plazas for I-5 and I-205. Footprints that follow the guidelines are unlikely to be acceptable in the urban settings in Vancouver and Portland. **See Figures 2 and 3 in Appendix A.** Therefore, design exceptions/deviations will be needed to allow the plazas to fit within the built environment. Designs will need to be developed in cooperation with the local agencies, DOT, and FHWA with jurisdiction for approval.

- Based on an initial review of potential northbound and southbound plaza sites, it appears easier to site a toll facility in the southbound direction in either Washington or Oregon for both I-5 and I-205. If only I-5 is tolled in both directions, additional investigation will be needed to locate possible sites that will allow for toll collection facilities to be located opposite each other for ease of access, maintenance, and operation.

- The capital cost for constructing a toll plaza ranges from an estimated low of $110 million on I-205 to a high of $250 million on Hayden Island for the five locations that were evaluated. These costs did not include maintenance and operation costs, which will be included in the toll revenue projections. These costs are very conceptual based on limited design information and should not be used for any other purpose than recognizing the magnitude of costs associated with building a toll plaza. The analysis did not consider environmental impacts or the costs of avoidance or mitigation. Additional evaluation in the DEIS is recommended to provide better cost information.